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ABSTRACT

This set of 21 skill sheets for agricultural machinery was developed for use in high school and vocational school agricultural mechanics programs. Each sheet covers a single operational procedure for a piece of agricultural machinery, and includes: (1) a diagram, (2) a step-by-step operational procedure, (3) abilities or understandings taught, (4) materials needed, and (5) an evaluation score sheet. (BP)

The materials contained herein were developed by the Agricultural Education Department, Iowa State University in cooperation with Consultants in Agricultural Education, Iowa State Department of Public Instruction.

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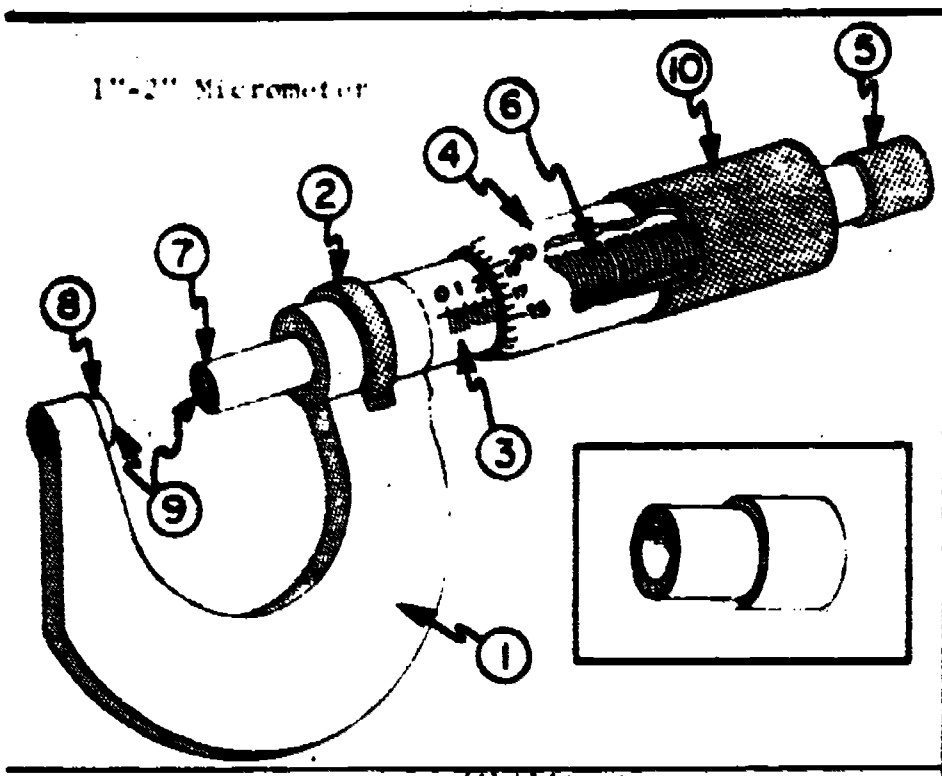
Additional copies of these "Skill Sheets for Agricultural Machinery" are available at $2.00 each for Dr. Thomas A. Hoerner, Agricultural Engineering Department, Iowa State University, Ames, Iowa 50010. Checks are to be made payable to the Agricultural Engineering Department.

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 1-72

READING THE MICROMETER

1"-2" Micrometer



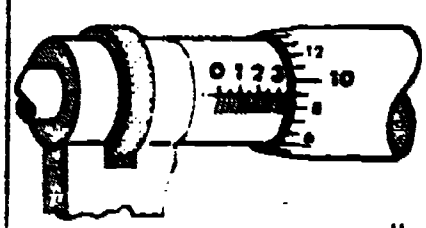
Part Identification:

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

Operational Procedure:

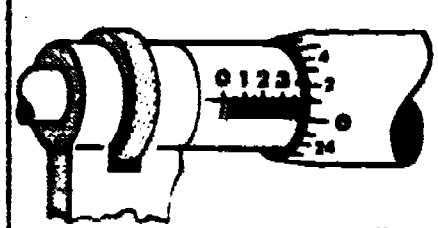
1. Complete the part identification section
2. Reading the micrometer:
   a. List the smaller number of inches that can be read with the micrometer illustrated to the left _____"
   b. Denote the number on the sleeve that the thimble edge just passed, this indicates the number of hundred thousandths _ _ _"
   c. Count the number of full spaces that is between the last numbered line (Step b) and the thimble edge and multiply by .025 _____"
   d. Locate the line on the thimble that matches the horizontal line on the sleeve and list this number in thousandths _____"
   e. Total the valves (a+b+c+d) _____"
3. Determining the measurements of the two-step machined, practice cylinder:
   a. Using a 1" - 2" micrometer list the measurement of the top step in thousandths. Proper measurement should be the average of measurements made at 3 points around the cylinder _____"
   b. Determine the measurement of the lower step _____"
   c. Subtract the reading in Step (b) from reading in Step (a) to determine the difference in thousandths of an inch _____"
4. Determine the readings of the micrometers shown below:

A. 0"-1" Micrometer



_____"

B. 2"-3" Micrometer



_____"

(Ability to .....
(Understanding of .....

Operation Teaches:

1. A. Identify the parts of the micrometer
2. U. The function of the various parts
3. U. The use of decimals and fractions in measurements
4. A. Convert fractions to decimals and decimals to fractions
5. A. Properly hold the micrometer
6. A. Feel a reading
7. A. Read the micrometer to the nearest one thousandths of an inch
8. A. Use the micrometer to measure flat, round or square stock

Evaluation Score Sheet:

Item	Points Possible	Points Earned
1. Micrometer part identification (2 points per correct item)	20	
2. Reading the micrometer	25	
3. Determining the difference in the measurements of the practice cylinder (3-c) (plus or minus .001" = 30 pts., + or - .002" = 20 pts., + or - .003" = 10 pts., greater than .004" off correct reading = 0 pts.)	30	
4. Determining the reading of the micrometer inserts (5 pts. each)	10	
5. Handling the micrometer	10	
6. Attitude and work habits	5	
Total	100	

Materials:

1 - 1" - 2" micrometer
1 - two-step practice cylinder (top step between 1.75" and 2.00" lower step 1.25" to 1.75")

Name: _____

_____ Grade: _____

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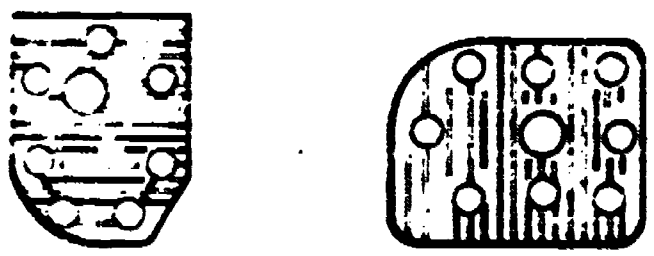
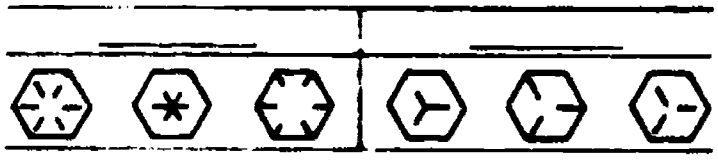
USING THE TORQUE WRENCH

TORQUE WRENCH



TORQUE SEQUENCE



S. A. E. GRADE NO.

Part Identification:

1. _____ 5. _____
2. _____ 6. _____
3. _____ 7. _____
4. _____ 8. _____

Operation Procedure:

1. Identify parts of torque wrench.
2. Identify grades of bolts pictured.
3. Determine the manufacturers' torque specifications: _____.
4. Convert from pound inch to pound feet as needed.
5. Determine the correct torque sequence on the engine head. Fill in sequence on heads pictured.
6. Set correct reading on wrench.
7. Select the correct sockets.
8. Measure run-down resistance if possible with torque wrench.
9. Add run-down resistance to torque setting.
10. Adjust for set or seizure if necessary.
11. Torque head bolts in correct sequence.
12. Torque spark plug.
13. Convert 840 pound inch to pound feet: _____.
14. Convert 40 pound feet to pound inch: _____.

Evaluation Score Sheet:

Item	Points Possible	Points Earned
1. Parts Identification	10	
2. S.A.E. Grade Ident.	10	
3. Pound Inches to Pound Feet	10	
4. Pound Feet to Pound Inches	10	
5. Correct Spark Plug Torque	10	
6. Correct Head Bolt Torque	10	
7. Correct Torque Sequence	20	
8. Handling the Equipment	10	
9. Attitude and Work Habits	10	
	100	

Name: _____

Date: _____ Grade: _____

Objectives:

Ability to.....
Understanding of...

Operation Teaches:

1. Identify the measurement parts.
2. Read inches and pound feet.
3. Use the operator's manual to determine the manufacturer torque specifications.
4. Convert measurements.
5. Set for seizure.
6. Identify it and use the torque wrench.
7. Identify grade number and bolt head identification marks.

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THE RPM TACHOMETER

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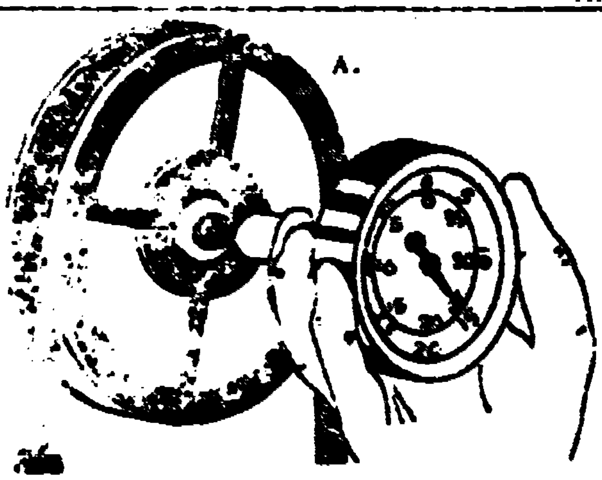
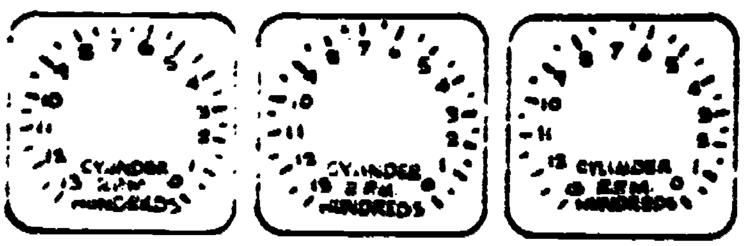


SMALL GRAIN	SOYBEANS	CORN

B.



[illegible]

RPM tachometer, 0-5000 RPM range
Combine manual

[illegible] Ability to.........
Understanding of...

1. [illegible] RPM.
2. [illegible] uses of the RPM tachometer.
3. A. [illegible] numbers to hundreds and seconds [illegible]
4. A. [illegible] specifications from a manual.
5. A. [illegible] and safely use the tachometer in determining the speed of a moving shaft.

[illegible] A. Hoerner

[illegible]	Points Possible	Earned
1. Questions 1 & 2, [illegible] pts per answer	21	
2. Questions [illegible], 5 pts per question	15	
3. [illegible], [illegible] pts per item	15	
4. [illegible], [illegible] pts per item	18	
5. [illegible] for using the [illegible]	20	
6. [illegible] & attitude	[illegible]	
Total	[illegible]	

Name ____________________

[illegible] Grade

Operational Procedure

1. Define the letters RPM.
   R ____________________
   P ____________________
   M ____________________
2. List 4 common uses of the tachometer in the agricultural mechanics field.
   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
3. The tachometer pictured to the left (A) has two sets of numbers on the face, study the instrument and discuss the purpose of the two sets of numbers.
   ____
4. Assuming the pulley in Figure A is turning clockwise and that this instrument reads in hundredths, what speed is this pulley turning in RPM? ____________.
5. A tachometer is a speed indicator. Not all speed indicators read directly in RPM's but rather it is necessary to count revolutions and record the seconds or minutes at the same time. If a shaft turns 125 revolutions in [illegible] seconds, what is the speed in RPM's? ________
6. Figure B to the left illustrates the tachometer on the instrument panel of a combine. Using the combine manual, draw in arrows or pointer lines giving the recommended speed or speed range for harvesting the crops listed above the three tachometers.
7. Determine the following recommended specifications in RPM's from the combine manual for harvesting small grain.
   a. Cylinder ____________________
   b. Beater ____________________
   c. Cleaning fan ____________________
   d. Straw walkers ____________________
   e. Engine, full load ____________________
   f. Engine, idle ____________________
8. Using a tachometer, check the speed of an engine, electric motor, combine shaft or other machine provided. Follow the below procedure for proper use of the tachometer.
   a. Determine the specifications in RPM for the machine ____________________.
   b. Before checking the speed, make sure all safety precautions are followed in working around a running machine or moving shaft.
   c. Study the correct procedures for using the tachometer available such as how to read, [illegible] to zero, etc.
   d. [illegible] tachometer in the right hand and [illegible]. Touch the rubber tip to the end of the [illegible] shaft.
   e. Record the speed of the shaft in RPM's ____

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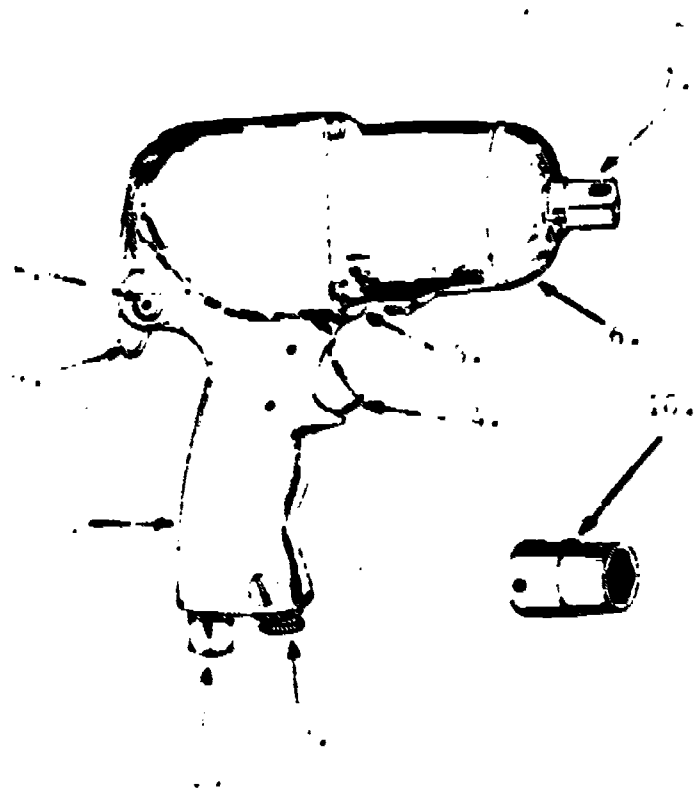

Materials Needed

Air impact wrench with sockets
Wheel and hub

Operation Teaches (Ability to.....
(Understanding of...

1. U. The uses of the air impact wrench.
2. A. Identify parts of air impact wrench.
3. A. Select correct type and size of sockets.
4. A. Select correct torque settings.
5. A. Properly use air impact wrench.

Evaluation Score Sheet

Item	Points Possible	Points Earned
Part identification (3 each)	30	
Discussion questions (4 each)	20	
Correct operation of wrench	40	
Attitude and work habits	10	
Total	100	

Developed by Herbert E. Hansen

Name _____

Date _____ Grade _____

Part identification

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

Operational Procedure

1. Complete part identification section.
2. Using the impact wrench - insert correct size socket on impact wrench. Determine torque specification for bolt _____ ft. lbs.
3. Connect impact wrench to compressed air supply making sure all hose and pipe fittings are secure.
4. Set compressed air pressure at 90-100 PSI.
5. Select torque setting on output torque control valve.
6. Set reversing valve for proper direction of rotation.
7. Check direction of rotation by compressing trigger switch for a short burst.
8. Holding wrench securely, apply socket to nut or stud and compress trigger switch.
9. When nut or stud begins to tighten, do not keep trigger switch compressed for more than 5 seconds.
10. Torque setting may be checked by loosening nut or stud with a torque wrench. Breakaway torque will be approximately 80% of tightening torque.
11. Amount of torque applied _____ ft. lbs.
12. If more or less tightening torque is needed, adjust output torque control valve.

Discussion Questions

1. What type of socket must be used with the air impact wrench? _____
2. What provision is made for lubricating your impact wrench? _____
3. What may happen if air pressure is to high? _____
   Too low? _____
4. What could be the effect of continuing to tighten nut or stud beyond 5 seconds? _____
5. List 4 jobs where an air impact wrench could be used. _____

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... 5-72

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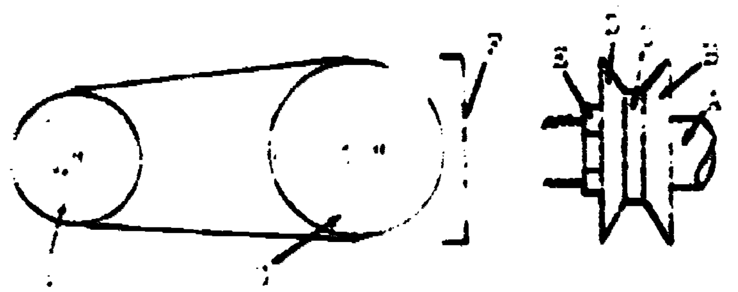
... Objectives: Ability to.........
(Understanding of...

1. A. Calculate speed of driven pulley
2. B. Application of power train
3. A. Identify component parts
4. A. Seat a belt properly
5. A. Set proper tension on belt



... DRIVEN

... Procedure:

1. Identify parts:

A.	________	E.	________
B.	________	F.	________
C.	________	G.	________
D.	________	H.	________

2. ... pulley speeds in your oper... ________ for the driver pulley ________ for the driven pulley.

Formula:

... = Diameter of large pulley / ... diameter of small pulley

Example problem:

If driver pulley RPM is 1750, what is speed of driven pulley? ____

$$\frac{1750}{x} = \frac{10}{4}$$

Multiply both sides by x and 4 then cancel

$$10x = 7000$$

Divide both sides by 10.

$$x = 700$$

When two pulleys are connected by a belt, the large pulley runs slower than the small pulley.

...
...

3. What pulley ... the optimum speed of your ... driver pulley=____" and driven pulley=____".

4. What change would you ... of the driven pulley ... leaving the driver pulley ... ________

5. What part of "V" belt must ... with pulley? ________

6. How much tension should be maintained on belt? ________

Evaluation Score Sheet:

Item	Possible	Earned
1. Identify parts	[illegible]	
2. Obtain data from manual	[illegible]	
3. Calculations	[illegible]	
4. Demonstration of changing speeds	[illegible]	
5. Demonstration of belt tension	[illegible]	
6. Attitude	[illegible]	
7. Handling equipment	[illegible]	
	[illegible]	

Materials:

Combine or other variable speed pulley system machine
Operator's manual
Speed indicator, ruler and tools

Name: ________

Date: ________ Grade: ________

DEPARTMENT OF AGRICULTURAL ENGINEERING
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AM 12-72

HORIZONTAL PLOW HITCH ADJUSTMENT

Identification

1. _____
2. _____
3. _____
4. _____
5. _____

Operational Procedure

1. Complete the identification section.
2. Define each of the following terms:
   a) Center of pull _____
   b) Center of load _____
   c) Line of draft _____
   d) Line of hitch _____
   e) Line of pull _____
3. Example of finding the center of load (CL) for a 5-16" plow.

   $CL = \frac{5 \times 6}{2} + 1/4 \times 16 = 40 + 4 = 44"$

4. Size plow available _____.
5. Determine location of center of load.

   $\frac{\text{x}}{2}$ + 1/4 x ____ = ____ + ____ = ____

6. Adjustment of wheel spacing: Determine correct wheel spacing of tractor. Refer to operator's manual for plow available.
7. Hitch plow to tractor and put land wheels on 6" blocks. Make sure tractor and plow are parallel to line of travel.
8. Using chalk line, snap a line on shop floor inside furrow wheel of tractor and extending back the length of plow. Be sure line is parallel with direction of travel.
9. Measure horizontal distance from furrow wall to center of load. (found in no. 5)
10. Stretch a string between center of load and center of pull. This is the "line of draft" of the plow.
11. The line of hitch, line of pull & line of draft should all be together. If they are not, consult operator's manual and make necessary hitch adjustments.
12. If plow is too wide to adjust tractor wheel spacing for on center hitching as determined, equalize side draft on both plow and tractor. Follow procedures as given in operator's manual for specific plow for off-center hitching.

Materials Needed

a. Tractor and plow
b. Three 6" x 6" x 2" blocks
c. String, chalk line, folding rule or tape
d. Operator's manual and reference - Plows and Plowing, Dept. Agr. Ed., Ohio State U.

Developed by Marvin D. Nettis
Edited by W. Howard Breece

Performance (Ability to.....
(Understanding of...

1. A. Identify points to consider in plow hitch alignment.
2. A. Forces acting upon plow.
3. A. Plow hitching and alignment terms.
4. A. Align the plow for the least draft.
5. A. Align the plow for the least wear.
6. A. Align the plow for quality plowing.

Evaluation Score Sheet

	Points Possible	Points Earned
1. Identification, 5 pts each	25	
2. Properly adjusted tractor wheel spacings	20	
3. Determining the distance between the center of load and the furrow wall	20	
4. Properly adjust drawbar hitch	25	
5. Attitude and work habits	10	
Total	100	

Name _____

Date _____ Grade _____

DEPARTMENT OF AGRICULTURAL ENGINEERING
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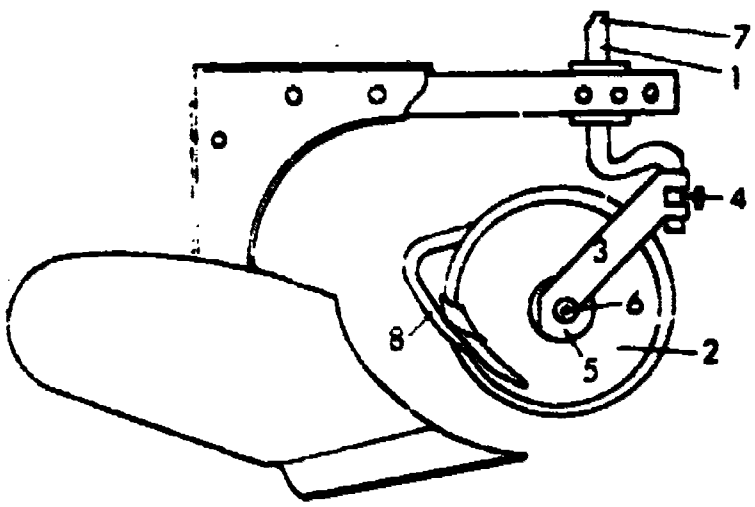
AM 14-72

PLOW COULTER ADJUSTMENT



Operation Teaches: (Ability to.....
(Understanding of..

1. A. Adjust coulter for various soil and trash conditions.
2. A. Identify coulter parts and attachments.
3. U. Coulter adjustment terms.
4. A. Properly use torque wrench.
5. U. Coulter settings - for quality plowing.

Material Needed:

1. Plow with coulters and attachments.
2. Assorted wrenches.
3. Torque wrench 200 ft. lb. capacity.
4. Six foot tape measure.
5. Operator's manual and reference - Plows and Plowing, Dept. Ag. Ed., Ohio State University.

Evaluation Score Sheet:

Item	Points Possible	Points Earned
1. Part Identification	16	
2. Fore-aft Adjustment	15	
3. Horizontal Adjustment	15	
4. Depth Adjustment	15	
5. Torque Adjustment	10	
6. Set collar Adjustment	10	
7. Handling Equipment	9	
8. Attitude and Work Habits	10	
Total	100	

1. _____ 5. _____
2. _____ 6. _____
3. _____ 7. _____
4. _____ 8. _____

Operational Procedure:

1. Complete part identification.
2. Find recommended fore-aft, horizontal and depth settings for coulters on available plow.
3. Perform coulter adjustment.
   a. Loosen shank clamp and make fore-aft adjustment.
   b. For 7" plow depth, raise or lower coulter to cut _____" deep.
   c. Twist shank so coulter is _____" to left of landside.
   d. Make adjustment with coulter blade parallel to landside.
   e. Tighten set collar to allow _____ _____.
   f. Torque bracket bolts to _____ ft. lbs. as recommended in manual.
4. List other coulter types available:
   a. _____
   b. _____
   c. _____
5. For abnormally hard soil the coulter should be moved _____ and _____.
6. For heavy trash conditions select _____ size coulter.
7. Give an advantage for each of the following:
   a. Notched blade coulters _____ _____.
   b. Fluted blade coulters _____ _____.
   c. Concave disk coulters _____ _____.
8. If a jointer is used:
   a. Adjust jointer to cut _____" below the ground surface.
   b. Jointer-coulter clearance should be _____".
   c. On some plows the _____ replaces the jointer.

Name: _____

Date: _____ Grade: _____

Developed by: Dewitt S. Shelton
Edited by : Mervin D. Bettis

DEPARTMENT OF AGRICULTURAL ENGINEERING
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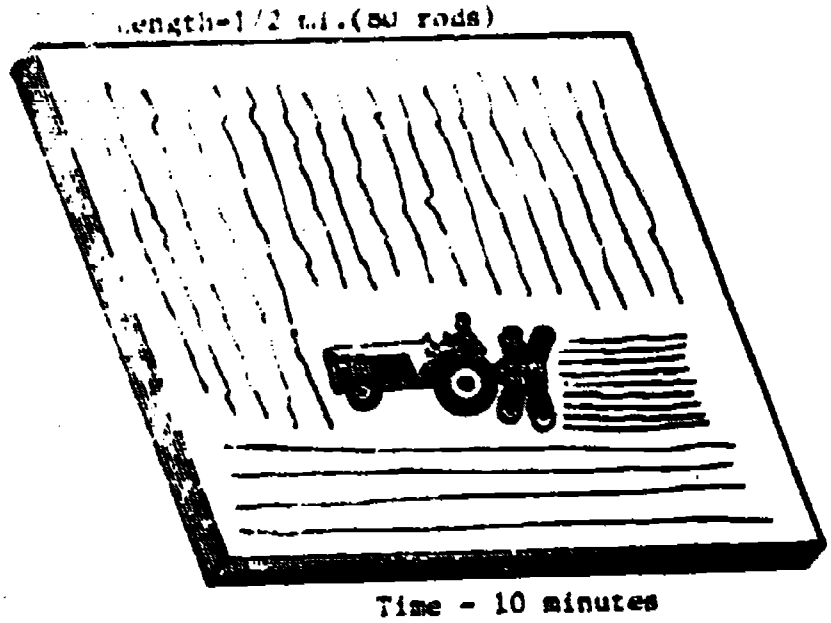
MACHINE ACREAGE CAPACITY



Time - 10 minutes

Objectives (Ability to.....
(Understanding of...

1. A. theoretical field capacity of a machine.
2. A. effective field capacity of a machine.
3. A. field efficiency of machine use.
4. A. determine field travel speed in miles per hour.
5. A. determine theoretical field capacity of an implement.
6. A. determine effective field capacity of an implement.
7. A. determine field efficiency of an implement.

Range in Field Efficiency for Common Machines

Moldboard plow	75-80%	Corn plan only	60-75%
Disk harrow	77-90%	Corn plan plus	45-65%
Field cultivator	75-85%	Combine	60-75%
Spring, tooth harrow	65-70%	Corn picker	55-70%
		Weather	70-85%
Row cultivation	65-85%	Sprayer	55-85%
Rotary hoe	80-88%		

Evaluation score sheet

Item	Points Possible	Earned
1. Field travel speed	10	
2. Theoretical field capacity	15	
3. Effective field capacity	10	
4. Field efficiency	15	
5. Plan machine work capacity	15	
6. Attitude and work habits	20	
Total	100	

Developed by Gilbert J. Hoff

Field Travel Speed (MPH) Determination

A 14 ft. tandem disc is pulled across a field 1/2 mile long (80 rods) in ten minutes. What is the ground speed in MPH? (1 mile = 5280 ft.; 1 rod = 16.5 ft.)

$$MPH = \frac{\text{ft. traveled}}{\text{Min. x 88}} = \frac{\quad\text{ft.}}{\quad\text{x 88}} = \quad$$

Theoretical Field Capacity of a Machine (TF Cap.)

$$\text{TF Cap.} = \frac{\text{MPH x implement width in feet}}{8.25} = \text{A/hr.}$$

Problem: 14 ft. tandem disc is drawn at 4.5 MPH. Find the TF Cap. in A/hr.

$$\text{TF Cap.} = \frac{\quad\text{MPH x }\quad\text{ft. wide}}{8.25} = \quad\text{A/hr.}$$

Effective Field Capacity (EF Cap.)

$$\text{EF Cap.} = \frac{\text{acres covered or worked}}{\text{hours of time used}} = \text{A/hr.}$$

Problem: A 14 ft. tandem disc is used to till 38 acres in 10 hours. Find the EF Cap. in A/hr.

$$\text{EF Cap.} = \frac{\quad\text{acres}}{\quad\text{hours required}} = \quad\text{A/hr.}$$

Field Efficiency (Field Eff.)

$$\text{Field eff.} = \frac{\text{EF Cap.}}{\text{TF Cap.}} \times 100$$

Problem: Find the field eff. of discing when the theoretical field capacity is 5.6 acres and the effective field capacity is 3.8 acres.

$$\text{Field eff.} = \frac{\text{EF Cap. }\quad\text{A/hr.}}{\text{TF Cap. }\quad\text{A.hr.}} = \quad\text{x 100} = \quad\%$$

Machinery Use Planning

EF Cap. = TF Cap. x field eff. = Acres per hour

Problem: Find the acres of corn that can be planted with a 4-36" row planter being drawn at 3 MPH. The field eff. expected is 60%.

$$\text{TF Cap.} = \frac{\quad\text{MPH x }\quad\text{ft. wide}}{8.25} = \quad\text{A/hr.}$$

EF Cap. = ___ TF Cap. x ___ field eff. = __ A/hr

Name _____

Date _____ Grade _____

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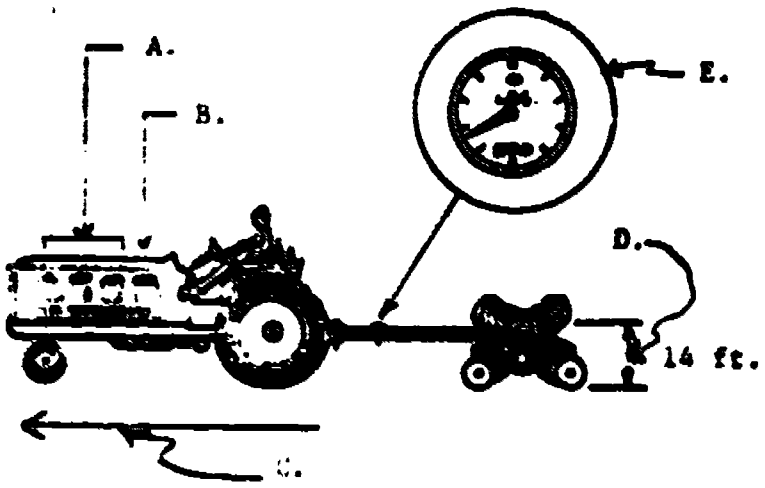
MATCHING HORSEPOWER NEEDS - TRACTOR SIZE AND MACHINE SIZE



Definition Matching (Ability to..... (Understanding of...

1. C. A method of determining horsepower needed on a tractor.
2. E. A method of matching machine size to tractor horsepower.
3. A. Identify factors affecting horsepower requirements of a tractor.
4. A. Find the tractor size needed for a field operation.
5. A. Find the largest machine size suited to a tractor.

Machine	Draft per foot width	Speed in MPH
Moldboard plow	850 lbs.	3.3-5.0
Disk, stalk ground	250	3.7-4.7
Disk, sward ground	280	3.5-6.0
Spike tooth harrow	180	3.5-7.2
Row crop cultivator	150	2.0-5.7
Field chopper, green forage	600	3.3-4.6
Chopper, hay or straw	200	3.3-4.6
Mower, rotary	1250	3.0-4.5
Corn planting	650	2.5-3.5

Evaluation Data Sheet

Item	Points Possible	Points Earned
1. Definitions	5	
2. Problem 1	15	
3. Problem 2	15	
4. Problem 3	30	
5. Problem 4	30	
6. Attitude and work habits	5	
Total	100	

Name _____

Date _____ Grade _____

Definition Matching

A. _____ 1. Implement width
B. _____ 2. Horsepower
C. _____ 3. Reserve horsepower
D. _____ 4. Speed, MPH
E. _____ 5. Total draft

Horsepower Need Determination

$$HP = \frac{\text{miles per hour} \times \text{total pounds draft}}{375}$$

1. Problem: What horsepower is required to pull a disk at 5 MPH? The disc has a total draft of 3920 pounds.

$$HP = \frac{\text{MPH} \times \text{lb. draft}}{375} = \text{HP}$$

Draw Bar Tractor Horsepower (dbHP)

Tractor draw bar horsepower needs are equal to the maximum draft load plus 25% to 30% for reserve power.

$$\text{dbHP} = \frac{\text{MPH} \times \text{total lbs. draft} \times 1.25 \text{ reserve}}{375}$$

2. Problem: How powerful a tractor is needed to pull a plow at 5 MPH? The plow has a total draft of 5100 lbs.

$$\text{dbHP} = \frac{\text{MPH} \times \text{lb. T. draft} \times 1.25}{375} = \text{dbHP}$$

Tractor Power Needs, Draft Per Foot Implement

Total implement draft = implement width x draft per foot.

3. Problem: What size tractor is needed to pull a 14 foot disk at 4 MPH. Disk draft for stalk ground (Use table for draft per foot).

___ ft. wide x ___ lbs. per ft. = ___ T. draft

Implement Sized to Tractor

$$\text{Impl. width} = \frac{375 \times \text{dbHP}}{\text{MPH speed} \times \text{draft of 1 ft.} \times 1.25} = \text{ft. width}$$

4. Problem: What size plow can a tractor with 80 draw bar HP pull at 5 MPH?

$$\text{Width} = \frac{375 \times \text{dbHP}}{\text{MPH} \times \text{draft per ft.} \times 1.25} = \text{ft}$$

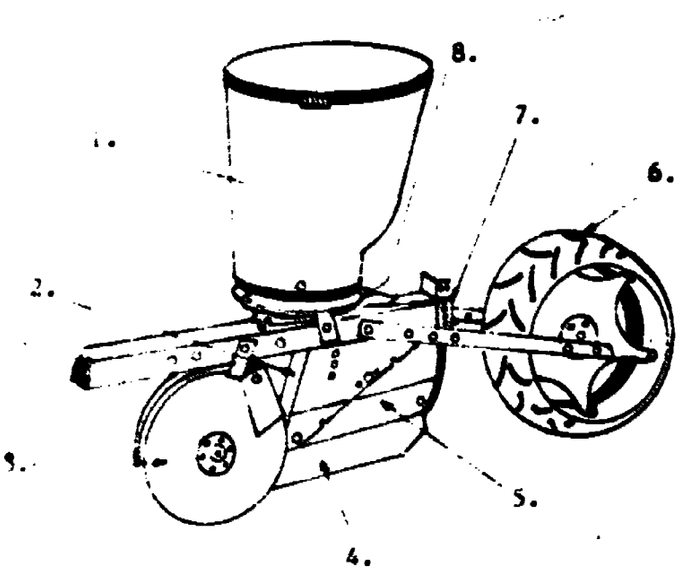
Number of 16" bottoms _____

Number of 14" bottoms _____

Developed by Hiser, J. Hoof

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 18-72

ROW CROP PLANTER UNIT



Part Identification	Function
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

Operation Teaches (Ability to.....
(Understanding of...

1. U. Types of planter units.
2. U. Function of planter unit components.
3. U. Adjustments and maintenance of planter units.
4. A. Change unit from hill drop to drill planting.
5. A. Adjust row crop planter unit.

Materials Needed

1. Row crop planter or single planting unit
2. Operator's manual for planting unit available

Evaluation Score Sheet

Item	Points Possible	Points Earned
1. Parts identification	16	
2. Function of parts	16	
3. Questions 3-7	20	
4. Maintenance of planting unit	10	
5. Description and adjustment of type of planting	25	
6. Attitude and work habits	13	
Total	100	

Developed by H. Edward Breece

Operational Procedure

1. Complete part identification section.
2. Write the major function on the line beside the part identified.
3. How is planting depth adjusted? _____
4. How is row spacing changed? _____
5. Row crop planters may be classified as to plate type and plateless. Which type planter unit do you have available for study? _____
6. Planters may also be classified as to how the planting mechanism is driven, carrying wheel drive or press wheel drive. Which type drive does your planter have? _____
7. How does changing from a 16- to a 24-cell seed plate increase planting rate? _____
8. Is the planting unit available now set for drill or hilldrop planting? _____
9. How should the planter unit be maintained?
10. How is the unit changed from (hilldrop to drill) or (drill to hilldrop) type planting?
11. Change the planting unit available from hilldrop to drill planting (or from drill to hilldrop planting) following the instructions in the operator's manual.

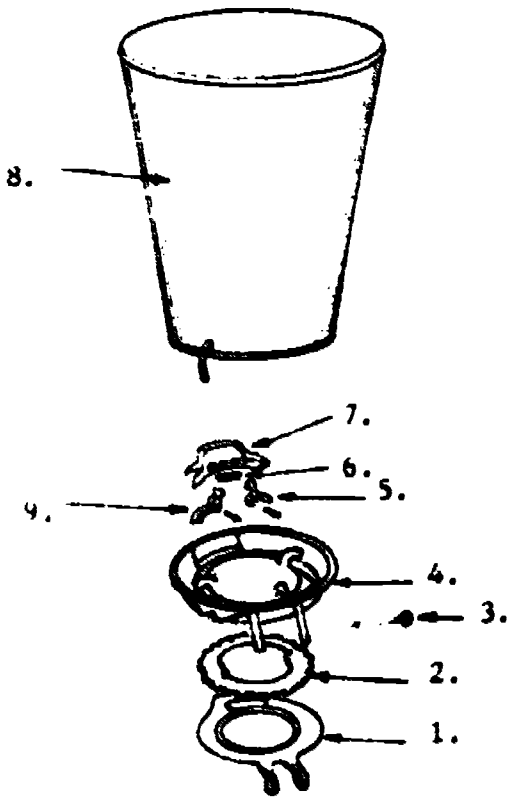
Name _____

Date _____ Grade _____

NOTES

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 19-72

PLANTER SEED PLATE MECHANISM



Part Identification	Function
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____
7. _____	_____
8. _____	_____
9. _____	_____

Operation Teaches (Ability to.....
(Understanding of...

1. U. How a planter seeding mechanism works.
2. U. Function of each part.
3. A. Identify the parts.
4. A. Maintain and adjust a planter seeding mechanism.

Materials Needed

1. Row crop planter or hopper and hopper bottom from planting unit
2. Operator's manual
3. hand tools

Evaluation Score Sheet

Item	Points Possible	Points Earned
1. Part identification	18	_____
2. Function of parts	27	_____
3. Questions 4-7	12	_____
4. Seeding mechanism disassembly, maintenance & adjustment	28	_____
5. Attitude & work habits	15	_____
Total	100	_____

Operational Procedure

1. Complete part identification section.
2. Write major function on line adjoining name of part.
3. What adjustments are possible on the seed plate mechanism? _____
4. What type of seed plates may be used in the seeding mechanism you are studying? _____
5. How should the seed plate mechanism be maintained? _____
6. Is the seed plate mechanism removable from the seed hopper? _____ Why? _____
7. What materials are seed hoppers made of? _____
8. Disassemble the seed plate mechanism available and identify the parts.
9. What parts are most subject to wear? _____
10. Do they need to be replaced on this unit? _____
11. Clean mechanism, reinstall parts and make adjustments as required in operator's manual.

Name _____

Date _____ Grade _____

Developed by Marvin Calhoun
Edited by H. Edward Breece

NOTES

DEPARTMENT OF AGRICULTURAL ENGINEERING
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AM 22-72

CORN PLANTER CALIBRATION

$$\% \text{ seed plate fill} = \frac{\text{No. kernals collected}}{\text{No. cells in seed plate}} \times 100$$

Factors for Planting Rate at Row Widths Given

Row spacing	40"	36"	30"	20"
Feet	13.1	14.5	17.5	26.2

Operation Teaches (Ability to..... (Understanding of...

1. U. Factors influencing planting rate.
2. U. Importance of correct ground speed on planting rate.
3. A. Determine adjustment to give desired planting rate.
4. A. Field calibrate a corn planter.

Materials Needed

1. Corn planter
2. 16 or 24 cell seed plates to match seed corn available
3. Operator's manual
4. Assorted wrenches and hand tools

Developed by H. Edward Breece

Evaluation Score Sheet

Item	Points Possible	Points Earned
1. Factors influencing planting rate	20	
2. Speed	5	
3. Percent seed plate fill	20	
4. Figuring planting rate	20	
5. Field calibration	20	
6. Attitude & work habits	15	
Total	100	

Name _____

Date _____ Grade _____

NOTES

Operational Procedure

1. What are the major factors that influence planting rate?
   - A. _____
   - B. _____
   - C. _____
   - D. _____
   - E. _____
2. Will too fast a ground speed increase or decrease planting rate? _____
   Why? _____
3. Determine percent seed plate fill.
   - A. Remove the seed hopper
   - B. Count no. turns of planter drive wheel to cause seed plate drive to make one complete revolution.
   - C. Replace hopper with recommended seed plate installed.
   - D. Turn drive wheel required number of turns while catching seeds at bottom of runner.
   - E. No. cells in seed plate _____.
   - F. No. kernals collected.
   - G. Using formula at top of page, determine percent seed plate fill _____
   - H. Select another seed plate if percent fill is not within the 90-110 percent range.
4. Using operator's manual, determine correct sprocket settings for planting population desired. No. teeth drive sprocket _____
   No. teeth driven sprocket _____
   Other settings, if required _____
   Planting population desired _____
5. Make necessary adjustments.
6. Field check of planting rate.
   - A. Fill planter boxes, fertilizer, insecticide, etc.
   - B. Select gear and throttle setting to give speed recommended in operator's manual. Speed _____ MPH.
   - C. Plant 100-200 ft. Stop. Check depth of planting. Depth _____.
   - D. Uncover kernals. Measure distance in feet, given in table at top of page for your row spacing, down one row. Count kernals _____
     Population = No. kernals x 1000.
     Population = _____.
   - E. Check population in each row in at least two places.
   - F. Make necessary adjustments in depth and planting rate following instructional procedures in operator's manual.

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 25-72

CALIBRATING THE FARM SPRAYER FOR BROADCAST APPLICATION

Terms and Useful Information:

GPA - gal. per acre MPH - miles per hour
GPM - gal. per min. NS - nozzle spacing
PSI - lbs. per sq. in. 1 GPM = .0078 x oz./min.
oz./min. - ounces per minute

Nozzle Spacing Conversion for Nozzle Spacing other than 20 inches:

NS -	15	18	21	24
Factor -	1.33	1.11	.95	.83

To obtain GPM output, divide GPM by factor

To obtain application rate, multiply GPA by factor

Operation Teaches: (Abilities to.....
(Understanding of...

1. U. Sprayer calibration procedures
2. U. Effects of pressure and speed on GPA application
3. A. Determine desired nozzle output
4. A. Measure nozzle output
5. A. Change pressure and/or speed to obtain GPA desired
6. A. Use sprayer calibration guide

Example for Sprayer Calibration Guide:

1. Find the GPA broadcast rate desired on the left side of calibrating guide. (30)
2. Move horizontally to right until travel speed in MPH is reaches. (6)
3. Move straight down; read ounces per minute on bottom of guide for broadcast application. (oz./min. based on 20" nozzle spacing) (77)

Materials Needed:

2 qt. liquid measuring cup, graduated in ounces
Farm sprayer

Skill Sheet developed by H. Edward Breece

Operational Procedures:

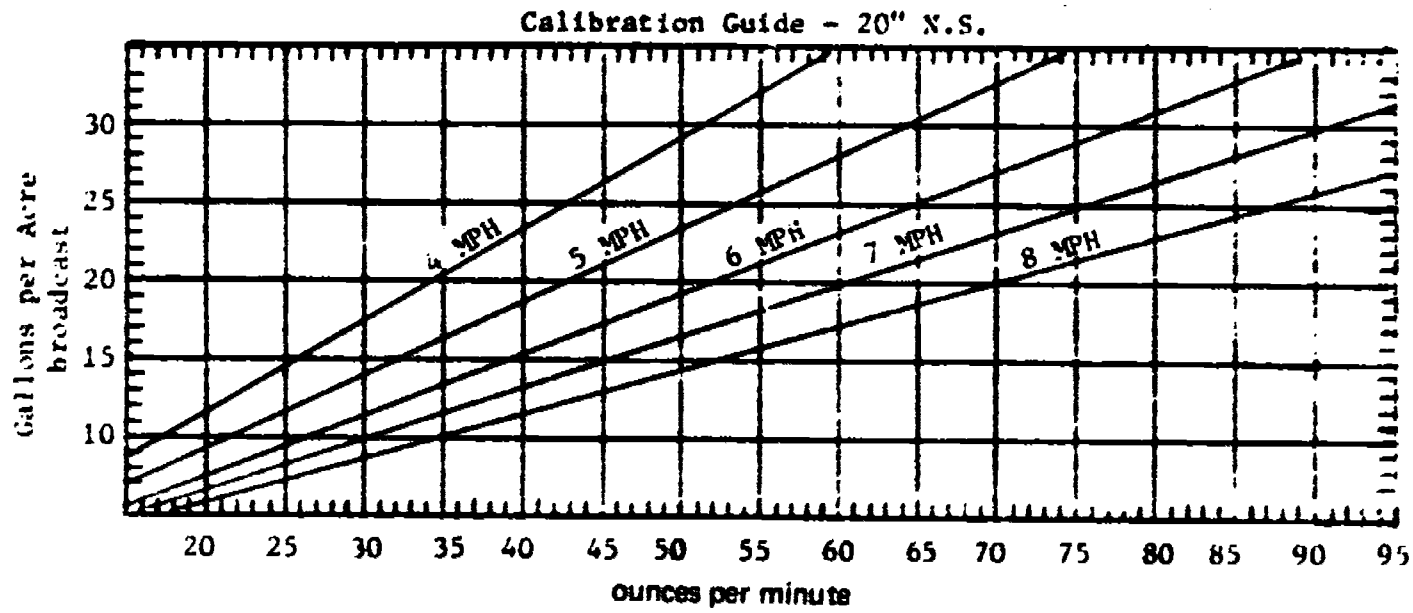
1. What is the output of each nozzle, (NS = 20") if rate of application is 20 GPA and speed is 5 MPH? _____
2. What is the GPM for each nozzle in #1? _____
3. What is the total GPM for the sprayer in problem #1 if it has 13 nozzles? _____
4. Determine the output per nozzle for sprayer in #1 if NS is 15" instead of 20". _____
5. Sprayer calibration exercise:
   a. Determine GPA rate required. _____
   b. Determine speed of travel. _____
   c. Determine nozzle spacing. _____ in.
   d. Determine output per nozzle required. (Use sprayer calibration guide) _____
   e. Start sprayer pump & run at rec. speed.
   f. Set pressure regulator to about 40 PSI.
   g. Collect nozzle output from at least 3 nozzles: 1_____ 2_____ 3_____ Average_____
   h. Adjust pressure until desired output is obtained or adjust speed to match actual nozzle output.

Evaluation Score Sheet:

Item	Points Possible	Points Earned
1. Questions 1-5	32	
2. Determine GPA and MPH	15	
3. Determine nozzle spacing	5	
4. Nozzle output from guide	10	
5. Determine nozzle output	15	
6. Adjust PSI and/or MPH to get correct GPA application	15	
7. Attitude and work habits	8	
	100	

Name: _____

Date: _____ Grade: _____



DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 20-72

CALIBRATING THE FARM SPRAYER FOR BAND APPLICATION

Terms and Basic Information:

GPA - gal./acre MPH - miles/hour
GPM - gal./min. NS - nozzle spacing
PSI - lbs./sq. in. 1 GPM = .0078 x oz./min.
oz./min. - ounces per minute

$$\text{GPA (band)} = \frac{\text{band width - in.}}{\text{row spacing - in.}} \times \text{GPA broadcast}$$

Nozzle spacing conversion for nozzle spacing other than 30 inches:

NS =	20	30	35	40	42
Factor =	1.27	0.83	0.79	0.75	0.71

To obtain GPM output, divide GPM by factor

To obtain application rate, multiply GPA by factor

Operation Teaches: (Ability to.....
(Understanding of...

1. U. Sprayer calibration procedures
2. A. Determine desired nozzle output
3. A. Measure nozzle output
4. A. Change pressure and/or speed to obtain GPA desired

Example for Sprayer Calibration Guide:

1. Find the recommended broadcast rate on the left side of calibration guide. (20)
2. Move horizontally to right until travel speed in MPH is reaches. (6)
3. Move straight down; read ounces per minute on bottom of guide (oz./min. based on 30" nozzle spacing and 14" band width). (36.2)
4. To change broadcast rate, GPA, to band rate =

$\frac{\text{band width}}{\text{row spacing}} \times \text{GPA broadcast} = (\frac{14"}{30"} \times 20 = 4.67 \text{ GPA})$

Materials Needed:

2 qt. liquid measuring cup, Farm sprayer

Operation Procedure:

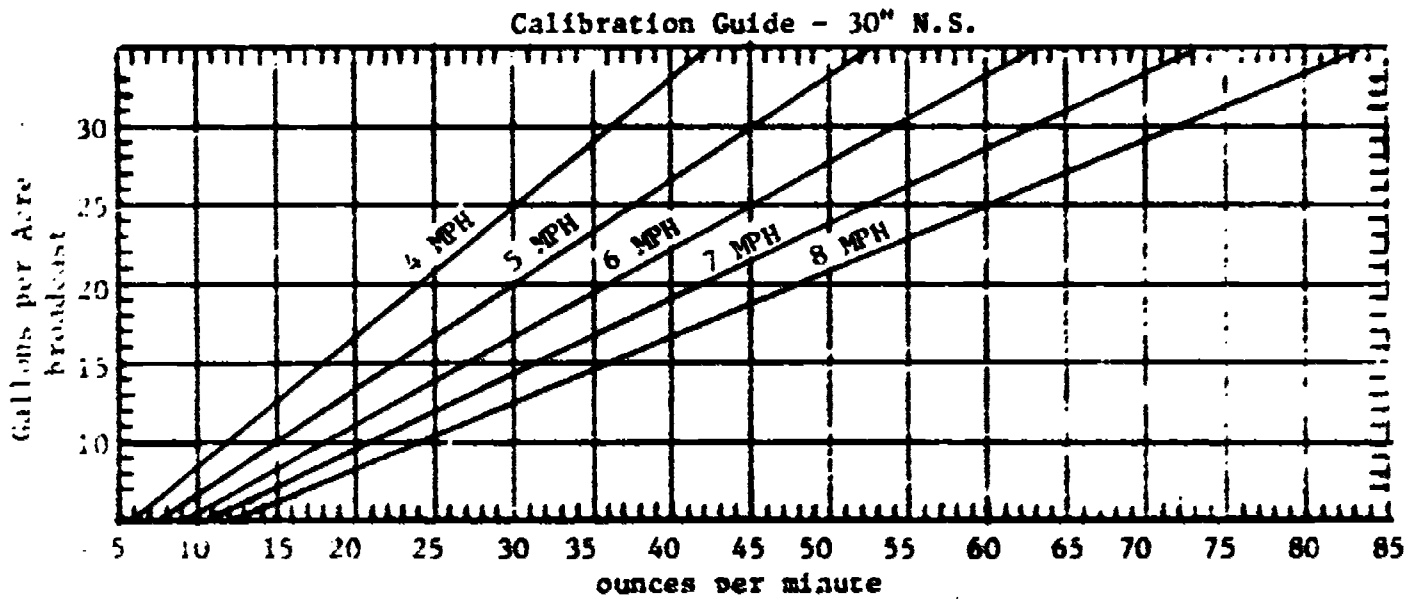
1. What is the output of each nozzle (NS = 30") if rate of application is 20 GPA (broadcast rate) and speed is 6 MPH? _____
2. What is the GPA rate of application in the band? _____
3. What is the nozzle output in GPM? _____
4. What is the total GPM for the sprayer in #1 if it is an 8-row sprayer? _____
5. Sprayer calibration exercise:
   a. Determine GPA broadcast rate required: ___
   b. Determine speed of travel desired: _____
   c. Determine nozzle spacing: _____
   d. Determine nozzle output to give desired band rate: (use guide) _____
   e. Run pump at recommended speed.
   f. Set pressure regulator to about 40 PSI.
   g. Collect nozzle output from at least 3 nozzles: 1_____ 2_____ 3_____ Average_____
   h. Adjust pressure and/or speed to match actual nozzle output.

Evaluation Score Sheet:

Item	Points Possible	Points Earned
1. Questions 1-5	30	
2. Determine GPA and MPH	10	
3. Determine nozzle spacing	10	
4. Nozzle output from guide	10	
5. Determine nozzles output	15	
6. Adjust PSI and/or MPH to get correct GPA application	15	
7. Attitude and work habits	10	
Total	100	

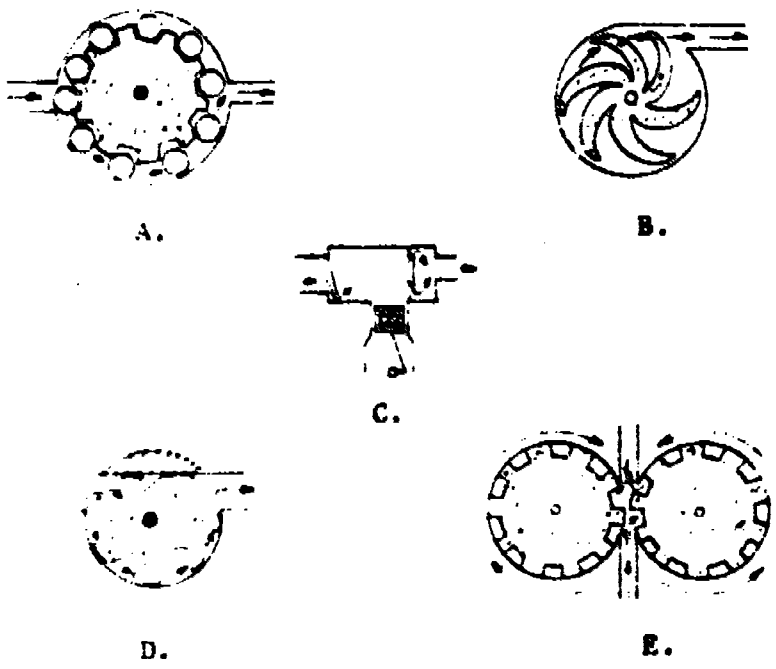
Name: _____

Date: _____ Grade: _____



DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 27-72

SPRAYER PUMPS



Operation Teaches (Ability to.....
(Understanding of...

1. A. Identify the types of sprayer pumps
2. U. How different pumps operate
3. U. Characteristics of sprayer pumps
4. A. Select correct pump

Developed by Dean Weber & Richard Clark
Edited by H. Edward Breece

Materials Needed

1. Skill Sheet - AM 25-72 - sprayer calibration
2. Sprayer operator's manual and/or reference on sprayer pumps

Operational Procedure

1. Identify the types of sprayer pumps.
2. Identify whether the pumps pictured are positive or variable displacement. Write a "P" or "V" on the line beside the kind of pump.

	Kind of Pump	P or V
A.		
B.		
C.		
D.		
E.		

3. Define:
   PSI _____
   GPM _____
   RPM _____

4. Characteristics of each pump. List ranges for PSI, GPM and RPM.

	Kind	PSI	GPM	RPM
A.				
B.				
C.				
D.				
E.				

5. Which of the pumps is most commonly used with the wettable powder (abrasive) spray materials.
   _____ Why? _____

6. Example of figuring pump capacity in gallons per minute (GPM).
   (GPM = .0078 x oz./min.)
   (GPM for agitator = 3.2, GPM for by-pass = 3.0)
   a) Sprayer 13 nozzles
   b) 20 GPA application rate, broadcast
   c) Speed 5 MPH
   d) Nozzle spacing 20"
   e) Oz./min./nozzle (from calibration guide) = 43
   f) Oz./min. for 13 nozzles = 13 x 43 = 559
   g) GPM = oz./min. x .0078 = 559 x .0078 = 4.36
   h) Nozzle requirement + agitator requirement + by-pass requirement = GPM pump capacity needed. 4.36 + 3.20 + 3.0 = 10.56, pump capacity in GPM required.

7. Determine pump capacity needed.
   a) 16 nozzles, 20 inch spacing, broadcast.
   b) 30 GPA application rate.
   c) Speed 5 MPH.
   d) GPM for agitator - 3.2, for by-pass - 3.0.
   e) Oz./min./nozzle _____
   f) Oz./min. for all nozzles = _____ x _____ = _____
   g) GPM = _____ x _____ = _____
   h) Pump capacity GPM = _____ + _____ + _____ = _____

Evaluation Score Sheet

Item	Points Possible	Points Earned
Identification of pumps & type of displacement	25	
Characteristics of pumps	25	
Question #5	10	
Pump capacity problem	32	
Attitude & work habits	8	
Total	100	

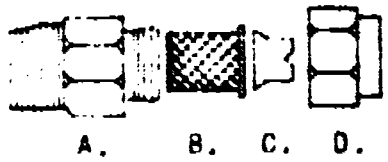
Name _____

Date _____ Grade _____

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 28-72

SPRAYER NOZZLES

SPRAYER NOZZLE



SPRAY PATTERNS

Operation Teaches (Ability to.....
(Understanding of...

1. U. Types of nozzles and their uses.
2. U. Different spray patterns and where each is used.
3. A. Identify parts of nozzle
4. A. Select nozzle tip
5. A. Care for nozzles

Developed by Jerry Krug
Edited by H. Edward Breece

Materials Needed

1. Sprayer operator's manual
2. Nozzle selection chart
3. Farm sprayer
4. Nozzle and nozzle tip samples

Evaluation Score Sheet

Item	Points Possible	Earned
Parts identification	16	
Pattern type & use	24	
Preparation for use	10	
Preparation for storage	10	
Questions 6 & 7	5	
Output check	15	
Changes to be made	10	
Attitude & work habits	10	
Total	100	

Nozzle Parts Identification

A. _____ C. _____

B. _____ D. _____

Spray Pattern Identification

	Type	Use
A.		
B.		
C.		

Operational Procedure

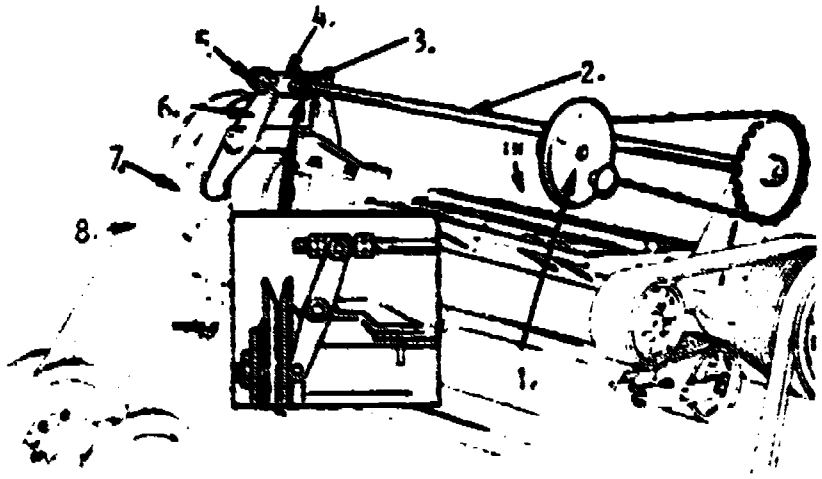
1. Complete part identification section.
2. Complete spray pattern identification and give common use for pattern.
3. Using nozzle selection chart, select nozzle tips for the following.
   a) Broadcast application, nozzle spacing 20 inches, 20 GPA rate, 5 MPH, tip no. ____
   b) Band application, 30 inch row spacing, 14 inch band, 7 GPA band rate, 5 MPH, tip no. ____
4. How should nozzles be prepared for use? _____
5. How should nozzles be prepared for storage? _____
6. What material are the nozzle tips made of on the sprayer provided? _____
7. How could you determine if the nozzle tips on your sprayer are putting out the correct amount of material? _____
8. Run a check on output of tips. (Use nozzle selection chart; convert oz./min. collected to GPM by multiplying oz./min. by .0078)
   a) Example: Collect 60 ounces in one minute from one nozzle. 60 x .0078 = .468 GPM Compare actual output with output listed for tip in nozzle selection chart.
   b) Check all tips separately.
   c) Is output more or less than specified? ____ Why? _____
9. What changes should be made to get desired application rate in GPA? _____

Name _____

Date _____ Grade _____

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 33-72

COMBINE CYLINDER SPEED ADJUSTMENT



Parts Identification

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Operation Teaches (Ability to..... (Understanding of...

1. A. Identify parts of cylinder drive unit.
2. U. Methods of adjusting cylinder speed.
3. A. Select correct cylinder speeds for various crops.
4. A. Make cylinder speed adjustments.

Developed by Gordon Kennedy & Clair Baker
Edited by H. Edward Breece

Materials Needed

1. Combine
2. Operator's manual, MF 410-510
3. Hand tools
4. Tachometer

Name _____

Date _____ Grade _____

Operational Procedure

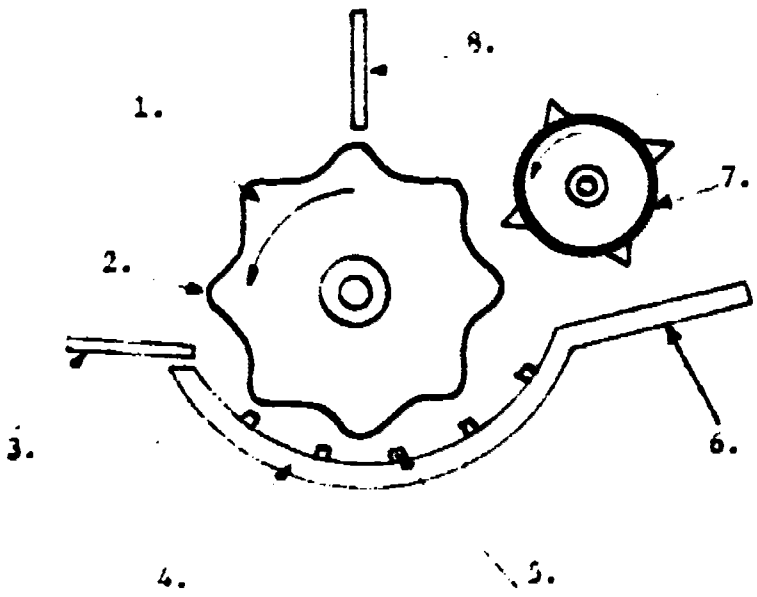
1. Complete part identification section.
2. Name the 2 methods of adjusting cylinder speed.
   a. _____
   b. _____
3. To increase cylinder speed, (increase) (decrease) diameter of driver, and (increase) (decrease) diameter of driven pulley or sprocket. (Circle correct answer)
4. Give recommended cylinder speeds for corn _____; soybeans _____; oats _____; wheat _____.
5. Check RPM of engine. (Usually checked at main separator drive)
   a. RPM recommended _____
   b. Actual RPM _____
   c. Make changes as required, follow instructions in operator's manual.
6. Check cylinder speed using tachometer _____.
7. See operator's manual for changes needed to get correct cylinder speed for crop.
   crop _____ speed _____
   changes required: _____
8. Make final check of cylinder RPM using tachometer. RPM _____
9. Should cylinder speed be increased or decreased if we find the following:
   a. Unthreshed heads _____
   b. Chopped straw in rack _____
   c. Excessive cracked grain in tank _____
   d. Ears not shelled completely _____
10. What other setting affects threshing action?
    _____

Evaluation Score Sheet

Item	Points Possible	Points Earned
Parts identification	15	
Methods of adj. cylinder speed	10	
Problem No. 3	10	
Recommended speeds for crops	12	
Check cylinder speed	5	
Check engine speed	5	
Changes required to get correct cylinder speed	10	
Final check of cylinder speed	5	
Problems	12	
Other settings	5	
Attitude and work habits	11	
Total	100	

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 34-72

COMBINE CYLINDER - CONCAVE CLEARANCE



Operation Teaches (Ability to.....
(Understanding of...

1. U. Importance of concave clearance.
2. U. Influence of clearance on threshing quality.
3. A. Select correct spacing for crop being harvested.
4. A. Adjust concave to get correct clearance.

Developed by H. Edward Breece

Materials Needed

1. Combine
2. Operator's manual
3. Gauges or round stock of correct diameter
4. Assorted hand tools

Evaluation Score Sheet

Item	Points Possible	Earned
1. Parts identification	24	
2. Questions 2-7	24	
3. Recommended clearances	8	
4. Measure cylinder-concave clearance	8	
5. Concave parallel	2	
6. Set clearance & check	20	
7. Question No. 14	10	
8. Attitude & work habits	4	
Total	100	

Name _____

Date _____ Grade _____

Parts Identification

1. _____ 5. _____
2. _____ 6. _____
3. _____ 7. _____
4. _____ 8. _____

Operational Procedure

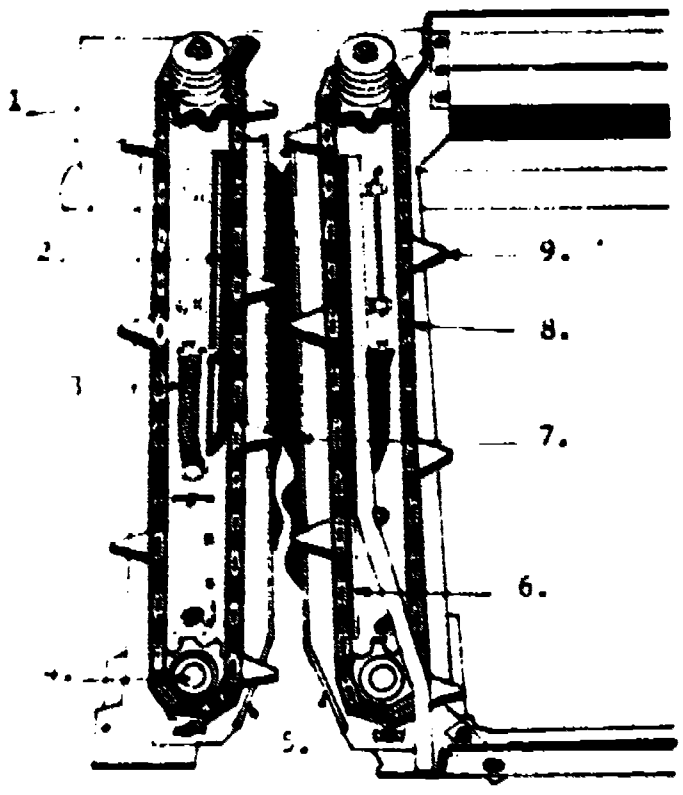
1. Complete part identification section.
2. To get the correct spacing between the cylinder and the concave, we adjust: (cylinder) (concave) _____
3. At what points should the cylinder to concave clearance be checked? _____
4. How is the front clearance changed? _____
5. How is the rear clearance changed? _____
6. Which clearance, front or rear, may be changed from the operator's platform? _____
7. Why is it important that the concave be level (parallel) with the cylinder? _____
8. What are the recommended clearances for the following crops?

	Front	Rear
Corn	_____	_____
Soybeans	_____	_____
Oats	_____	_____
Wheat	_____	_____

9. Measure the cylinder - concave clearance on the combine provided: front left _____
front right _____
rear left _____
rear right _____
10. Is the concave parallel with the cylinder both at the front and the rear? _____
11. Set the cylinder to concave clearance for the crop desired.
12. Check the clearances at all four points.
13. Is the concave parallel with the cylinder? ___ If not, make the necessary adjustments.
14. Should the cylinder to concave clearance be increased or decreased if we observe the following conditions?
    a) Ears not shelled completely _____
    b) Excessive damage to grain _____
    c) Straw or stalks chewed up _____
    d) Grain not threshed from heads _____
    e) Slugging or overloading of cylinder _____

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 38-72

COMBINE-STRIPPER PLATE ADJUSTMENT



Parts Identification

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

Materials Needed

1. Combine stripper plate type cornhead.
2. Operator's manual for cornhead.
3. Set of combination open end and box end wrenches ranging in size from 3/8" to 3/4".

Operation Teaches (Ability to.....
(Understanding of...

1. U. Function of stripper plates in cornheads.
2. U. Proper spacing of stripper plates.
3. U. Importance of having stripper plate openings centered over snapping rolls.
4. A. Use operator's manual to find proper settings and make necessary adjustments.

Operational Procedure

1. Complete part identification section.
2. Discuss the function of stripper plates on the cornhead _____
3. Using operator's manual, determine recommended settings for stripper plates.
   a. Lower end _____
   b. Upper end _____
4. Make stripper plate adjustment, using a block of wood precut to the indicated starting widths, adjust the lower and upper ends of the stripper plates snugly against the blocks, making certain that the stripper plates are centered over the snapping rolls.
5. Stripper plates are in correct adjustment when the ears are snapped _____ the distance from the lower end.
6. Adjust stripper plates on cornhead using operator's manual and procedure in No.3 above.
7. Operate the cornhead in the field. Observe all safety rules. Plugging at the upper end, rear of the plates are too close together; shelling at upper end, plates are set too wide apart; excessive ear flipping and loss, lower end of plates are too close together or stripper plates are not centered over snapping rolls.
8. Changes made in stripper plate adjustment after operating in field _____

Evaluation Score Sheet

Item	Points Possible	Points Earned
1. Parts identification	18	
2. Determining proper stripper plate adjustments from operator's manual	23	
3. Adjustment of stripper plates for clearance, upper & lower	25	
4. Field adjustment of stripper plates	25	
5. Attitude and work habits	9	
Total	100	

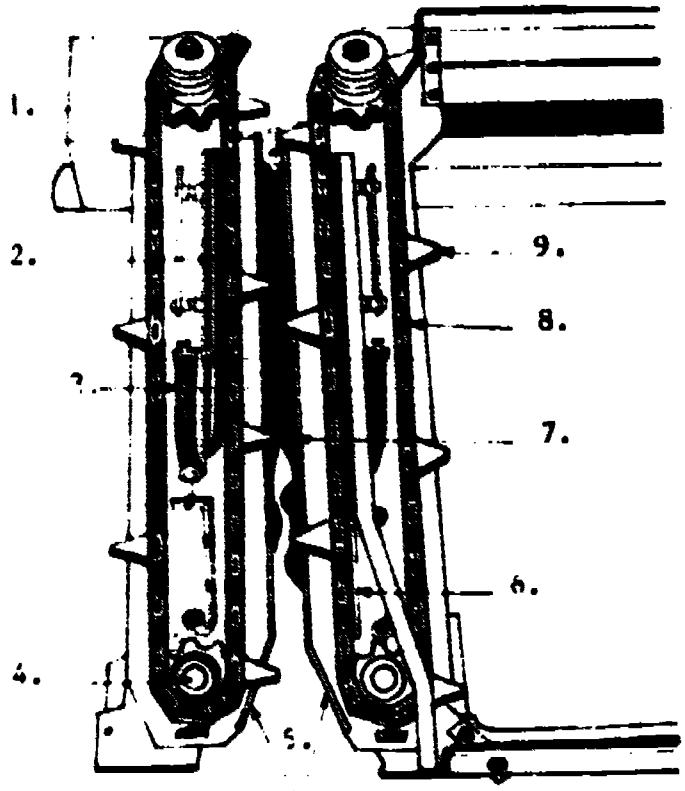
Developed by Art Miller
Edited by H. Edward Breece

Name: _____

Date: _____ Grade: _____

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 39-72

GATHERING CHAIN ADJUSTMENT



Part Identification

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

Materials Needed

1. Combine corn head
2. Assorted hand tools
3. Operator's manual

Operation Teaches (Ability to.....
(Understanding of...

1. A. Identify gathering chain parts.
2. U. Operation of gathering chains.
3. A. Use operator's manual to find gathering chain adjustment specifications.
4. A. Correctly adjust gathering chains.
5. A. Make final adjustments after observing field operation.

Evaluation Score Sheet

Item	Points Possible	Points Earned
Parts identification	27	
Questions 2-7	25	
Questions 8-9	10	
Adjustments made	25	
Attitude & work habits	13	
Total	100	

Developed by Gerald Burke
Edited by H. Edward Breece

Name: _____

Date: _____ Grade: _____

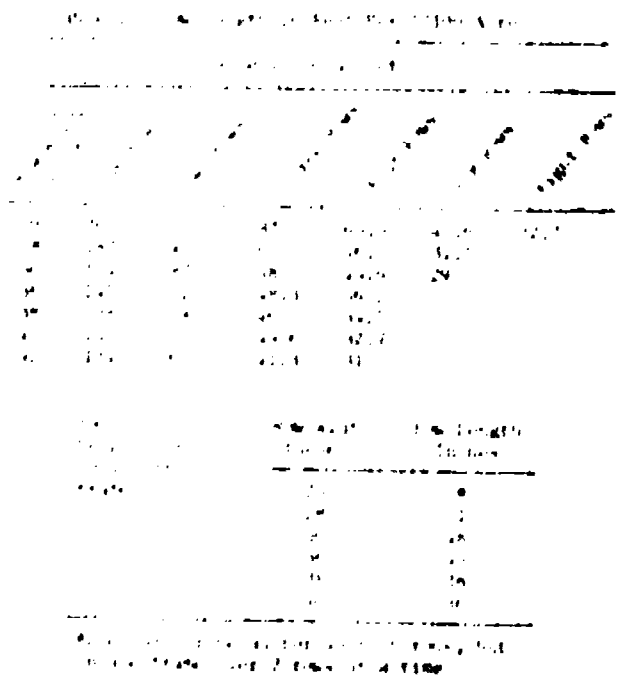
Operational Procedure

1. Complete part identification section.
2. Discuss the function of the gathering chains on a corn head _____
3. What gathering chain adjustments are possible on most corn heads? _____
4. How are these adjustments made? _____
5. How is chain tension maintained? _____
6. When is it necessary to remove links from the gathering chain? _____
7. How is each gathering chain & gathering drive protected? _____
8. Spring length (tension) required on corn head provided _____
9. Recommended position of chain guides on corn head provided _____
10. Make required adjustments on corn head.
11. Operate corn head in field. Observe all safety precautions. Are gathering chains operating correctly?

    If not, what further adjustments are needed? _____
12. Make final adjustments.

DEPARTMENT OF AGRICULTURAL ENGINEERING
IOWA STATE UNIVERSITY
AM 40-72

COMBINE HARVESTING LOSSES FOR CORN



Operation Teaches (Ability to.....
(Understanding of...

1. U. Extent of harvesting losses.
2. U. Types of losses.
3. U. How to reduce losses.
4. A. Measure harvest losses.
5. A. Identify problems causing harvest losses.
6. A. Make adjustments to reduce harvest losses.

Developed by Charles Perdue & Larry Bruxvoort
Edited by H. Edward Breece

Materials Needed

1. Combine & operator manual
2. Twine & stakes to make frame
3. Tape measure
4. Assorted hand tools

Name _____

Date _____ Grade _____

Operational Procedure

1. Name the types of harvest losses.

   _____ _____

   _____ _____

2. Total harvest losses should not exceed ____ bu./acre.
3. Stop combine at least 300' in from ends of field.
4. Back machine at least one full length of machine.
5. Behind machine measure length to give 1/100 acre for your width of machine. (Table 1)
6. Count ears found in this area. _____ Enter on lines (C) (B) of Table 5.
7. Count ears found in a like measured area in the corn not yet harvested _____ (A)
8. Gathering unit loss. Subtract A from B ___ (D)
9. Construct 10 sq. ft. frame using Table 2 to get length. Put frame over each row and average counts for steps 10, 11, & 12.
10. Count kernels in 10 sq. ft. area behind machine. Kernels still attached to cobs that have gone through machine. _____ (K)
    Total kernels _____ (M)
11. Count kernels in area just in front of machine. _____ (J)
12. Count kernels in area not yet harvested. ___(I)
13. Separating kernel losses. Subtract, M-J ___(L)
14. Gathering unit kernel losses. Subtract, J-I _____ (N)
15. Convert ear loss to bu./acre. See Table 3. Enter on lines (E)(F)(G)(H) of Table 5.
16. Convert kernel losses to bu./acre. See Table 4. Enter on lines (O)(P)(Q)(R)(S)(T) of Table 5.
17. Determine total harvest losses. Add ear loss to shelled corn loss. Enter on lines (U)(V)(W)(X)(Y)(Z) of Table 5.
    Total loss bu./acre (Y) _____
    Machine loss bu./acre, Y-U _____
18. Is machine loss within allowable limits? _____
19. If machine losses are excessive, make necessary adjustments.
20. Total machine losses after final adjustments have been made. _____